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16. ABSTRACT

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Causes of Death among Anesthesiologists: 1930–1946

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The causes of death among anesthesiologists from 1930 through 1946 were determined and compared to the causes of death for contemporaneous physicians as well as anesthesiologists in later eras. Names of US white male anesthesiologists listed in the annual Directories of Anesthetists compiled by the International Anesthesia Research Society were searched for in the death files of the American Medical Association. Among those listed in the Directories 274 deaths were located. Causes were ascertained for 269 deaths and 259 causes were verified from death certificates. The leading causes of death of anesthesiologists and other physicians of the same era were cardiovascular-renal diseases and malignant neoplasms. The death rate from all causes was lower among anesthesiologists than among contemporaneous white men and other physicians. Death rates among anesthesiologists from 1930–1946 were similar to those among anesthesiologists in 1947–1956, but greater than those for 1957–1971. Among deaths from malignant neoplasms, those of the digestive organs were the most frequent and those of the respiratory tract the least. Anesthesiologists practicing in the earlier part of this century had lower death rates and they were less likely to die of malignant neoplasms than contemporaneous white men. The death rates for these anesthesiologists were similar to those for anesthesiologists during 1947–1956, but greater than rates observed for anesthesiologists during 1957–1971. This suggests that exposure to the fluorinated anesthetic agents introduced in the mid-1950s may not be an important health hazard.

Key Words: ANESTHESIOLOGISTS: causes of death.

OCCUPATIONAL exposure to the vapors of inhalation anesthetics could be a health hazard and thus influence the mortality experience of anesthesiologists. (The word anesthesiologist came into use in the 1940s to describe physicians (MD) who gave anesthesia and to distinguish them from nonmedical anesthetists such as nurses. It is used here to describe all physician-anesthetists regardless of their period of practice.) The agents to which anesthesiologists have been exposed have changed over the years. In the early years, ether, nitrous oxide, and chloroform predominated. Chloroform, which has been shown to be a carcinogen in animals (1), was used during the latter half of the 19th century and into the 20th century. With the recognition of its side effects, and with the introduction of newer and safer drugs, the use of chloroform declined, so that by the mid-20th century, it was rarely used for anesthesia. If we consider anesthesiologists dying between 1930 and 1946 to average 65 years of age and 40 years of practice, these anesthesiologists would have given anesthetics between 1890–1946, during the later period of chloroform use. If chloroform causes long-term toxic effects, e.g., carcinogenesis, then mortality statistics for a large group of anesthesiologists should reflect this toxicity.

This study was undertaken to identify a population of anesthesiologists, to determine the causes of death of those who died during the years 1930–1946, and to compare these mortality statistics with those of other groups.

Methods

White male anesthesiologists living in the United States and listed in the annual Directory of Anesthetists of the International Anesthesia Research Society (IARS) were chosen as the population to be studied

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(2–6). The population was limited to white men by eliminating those with a given name of the female gender, or those who were listed as women or nonwhite in the American Medical Association death files or on the death certificate. The total population of male anesthesiologists was obtained by counting names that appeared in the IARS directories for 1930, 1935, 1938, 1941, and 1948. The age distribution of the population for these years was obtained by selecting, at random, a 5% sample of names from each of these directories. The year of birth for each individual was obtained from American Medical Directories (7–10). Ages were calculated and the percentage falling within each 10-year age group, starting at age 25, was determined. Numbers of anesthesiologists in each age group were enumerated for each year listed above. The population and age distribution for intermediate years were obtained by linear interpolation. The names of male anesthesiologists appearing in the IARS directories for the years 1930, 1935, 1938, and 1941 were searched for in the death files of the American Medical Association.

The directories of anesthetists were not membership lists of the IARS, rather they were lists of anesthesiologists, regardless of affiliation. Each directory solicited from its readers, names of physicians practicing anesthesia. These directories are the most complete lists of anesthesiologists available for the period and thus provide a sound basis for selection of a study population.

The names of anesthesiologists who died between January 1, 1930, and December 31, 1946, were recorded on index cards along with the date and place of death, age, cause of death, and last known address, when available. Copies of death certificates were obtained from the registrars of vital statistics of the various states and the City of New York to ascertain or verify the cause of death. These data make up the observed causes of death of male anesthesiologists, 1930–1946.

The death rates for selected causes observed in this population were compared to several other populations to evaluate possible differences in the causes of death. Two forms of comparison of death rates were used, the proportional death rate and the mortality ratio. The proportional death rate is the percentage of the total deaths attributable to a given cause. The mortality ratio is the ratio of deaths occurring in the study population and deaths expected to occur in a comparison population of similar age distribution. The four populations chosen for comparison of mortality ratios were: (*a*) US white men, 1930–1946 (11, 12); (*b*) US white male physicians, 1938–1942 (13, 14); (*c*) Metropolitan Life Insurance Company standard ordinary life insurance policyholders, 1966; and (4) members of the American Society of Anesthesiologists, 1947–1956, 1957–1966, and 1967–1972 (15, 16, and unpublished data of D. L. Bruce, K. A. Eide, H. W. Linde, and J. E. Eckenhoff). Proportional death rate comparisons were made only with US physicians, 1938–1942.

Expected death rates for US white men during 1930–1946 were calculated from US vital statistics rates (11) by averaging death rates for the years 1930, 1933, 1937, 1940, 1943, and 1946 for each 10-year age group between 25 and 84. Expected death rates for digestive and respiratory system neoplasms and leukemia and aleukemia were only available for 1940 (12). These expected death rates were adjusted to the age distribution of the anesthesiologist population. For each 10-year age group, the number of anesthesiologists at risk of death was multiplied by the expected US white male death rate for that age group to give the number of expected deaths of anesthesiologists. These expected deaths were summed for ages 25 to 84 and compared with the observed number of deaths. Expected death rates for male physicians (13, 14) and for standard policyholders of the Metropolitan Life Insurance Company were also age-adjusted to the 1930–1946 anesthesiologist population. These policyholder death rates were also used by Bruce et al (15, 16) in their studies of causes of death of anesthesiologists. Mortality ratios for anesthesiologists compared to contemporaneous white men for 1947–1956 and 1957–1966 were obtained from unpublished data of Bruce et al. Causes of death were classified according to the fifth revision of the International List of Causes of Death (17) for comparison with contemporaneous vital statistics rates and according to the seventh revision (18) for comparison with rates for life insurance policyholders and the data of Bruce et al (15, 16). Deaths coded according to the fifth and earlier revisions of the International List of Causes of Death did not include Hodgkin's disease or leukemia as malignant neoplasms and available vital statistics rates do not include these diseases with malignancies.

The standard deviation of a mortality ratio is approximately equal to mortality ratio/$\sqrt{\text{number of deaths}}$ if a normal distribution can be assumed for the number of deaths or the death rate. This assumption is reasonable when the number of deaths is greater than approximately 20 (19, 20). The 95% confidence limits equal 2 SD. These 95% confi-

dence limits refer to biologic randomness and do not include possible errors in the conduct of the study.

This investigation was reviewed and approved by the Institutional Review Board of Northwestern University.

Results

The names of 274 white male anesthesiologists, who were listed in IARS directories of anesthetists, and who died between January 1, 1930 and December 31, 1946, were located. Copies of death certificates were obtained for 259 of these deaths. In 15 instances, death certificates were not available. Overall, 259 causes of death were obtained from death certificates, 10 from the American Medical Association files, and five remain unknown.

The numbers and age distribution of the anesthesiologists who were included in this study are shown in Table 1. The deaths occurring among these anesthesiologists over the period 1930–1946 are given by cause and age at death in Table 2. In Table 3, the proportional death rates of this group of anesthesiologists are compared to US physicians during 1938–1942 (13, 14). In Table 4, the age-adjusted mortality ratios observed in the study population to those expected among contemporaneous US white men are shown; 95% confidence limits are given for the major causes of death. For comparison, similar mortality ratios are shown for anesthesiologists in the subsequent two decades and for US physicians during 1938–1942.

Age-adjusted mortality ratios were also derived by comparing the subjects of this study to those of male standard ordinary policyholders of the Metropolitan Life Insurance Company (Table 5).

The leading causes of death among anesthesiologists during 1930–1946 were cardiovascular-renal diseases and malignant neoplasms. The same was true for all physicians of the same era. The comparatively high rates for suicide and the low rates for respiratory malignancies are notable. Infectious diseases also claimed a high proportion of lives.

The observed mortality ratios suggest that the death rate for anesthesiologists in this study was lower than that for US white men for most causes. Mortality from all malignant neoplasms, as well as those of the individual systems, was lower than among the white male population, especially for respiratory malignancies.

The death rate for all causes in the study population

TABLE 1

White Male Anesthesiologist Population and Age Distribution

Age range	Year (population)				
	1930 (1119)	1935 (1099)	1938 (1418)	1941 (1634)	1948 (1972)
yr			%		
25–34	10.4	11.5	11.8	16.5	9.4
35–44	32.3	34.4	32.9	28.2	33.0
45–54	31.8	29.5	28.9	21.2	31.1
55–64	20.9	21.3	15.8	22.4	21.7
65–74	4.5	3.3	10.5	10.6	3.8
75–up	0.0	0.0	0.0	1.2	0.9

TABLE 2

Death of White Male Anesthesiologists, 1930–1946, by Age and Cause*

Cause of death	Age (yr)						Total
	25–34	35–44	45–54	55–64	65–74	75–up	
All causes	9	26	52	93	64	30	274
Cardiovascular renal	1	10	29	62	51	20	173
Vascular lesions of the CNS	0	2	7	10	13	3	35
Diseases of heart	1	7	19	47	34	11	119
Chronic and unspecified nephritis	0	0	2	4	1	3	10
Malignant neoplasms	4	1	4	11	8	3	31
Digestive	2	1	1	8	5	1	18
Respiratory	0	0	0	1	0	0	1
Leukemia and aleukemia	1	0	0	0	0	0	1
Lymphosarcoma	0	0	3	0	0	0	3
Accidents	0	2	4	2	0	2	10
Suicides	0	2	4	4	0	0	10
All other causes	4	11	11	14	5	5	50
Infection	4	6	5	2	2	1	20
Cause unknown	0	0	2	1	1	1	5

* Total deaths listed by major category (italic) and specific causes (roman); deaths from specific causes are included in the major categories. Sum of the deaths in each major category ("All causes") equals the "Total."

was similar to that of life insurance policyholders; however, rates for certain causes differed. Death rates from suicides and vascular lesions of the central nervous system in the study population were more than twice that of the policyholders. Cancer death rates were low, except for deaths due to malignancies of the digestive organs. Respiratory cancer rates were especially low among anesthesiologists.

Discussion

Sources of Information

Three sets of records form the basis of this investigation, the directories of anesthetists of the IARS, the death files of the American Medical Association, and vital statistics records of the states and New York City. The records of the American Society of Anesthesiologists and predecessor societies were also examined. These latter records, although providing some information on deaths, are too incomplete during the era under study to be useful in this study.

The American Medical Association (AMA) published the American Medical Directory, *A Register of Legally Qualified Physicians of the United States*. The Directory was published at 2- or 3-year intervals from 1906 through 1942 and then again in 1950. To prepare this directory, the AMA maintained a file card for each physician in the United States. Medical school graduation lists, information from state boards of registration in medicine, medical societies, etc were the sources used to prepare this file. Physicians were asked routinely to provide information to update their listings. The file cards usually contain the physician's name, date of birth, sex, race if other than white,

TABLE 3

Proportional Death Rates of Anesthesiologists and US Physicians*

Cause of death	Anesthesiologists 1930–1946†	US physicians 1938–1942‡
	%	
Cardiovascular-renal diseases	63.1	59.8
Vascular lesions of the CNS	12.8	10.8
Diseases of the heart	43.4	40.7
Chronic and unspecified nephritis	3.6	5.9
Malignant neoplasms	11.3	10.3
Digestive	6.6	4.3
Respiratory	0.4	1.0
Leukemia, aleukemia	0.4	0.6
Lymphoid, reticuloendothelial system	1.1	—§
Accidents	3.6	4.6
Suicides	3.6	1.9
All other causes	18.2	23.4
Infection	7.3	—§
Cause unknown	1.8	1.2

* Total deaths listed by major category (italic) and specific causes (roman); percent of deaths from specific causes are included in the major categories.

† This study.

‡ US white male physicians, 1938–1942 (13, 14).

§ Not available.

TABLE 4

Mortality Ratios of Anesthesiologists and US Physicians to US White Men*

Cause of death	Anesthesiologists 1930–1946†	Anesthesiologists 1947–1956‡	Anesthesiologists 1957–1966‡	US physicians 1938–1942§
All causes	0.76 ± 0.092	0.74	0.51	1.02
Cardiovascular-renal	1.01 ± 0.154	1.07	0.54	1.12
Vascular lesions of CNS	1.25 ± 0.422	0.75	0.65	1.20
Disease of heart	1.06 ± 0.194	1.39	0.60	1.18
Chronic and unspecified nephritis	0.40	1.03	2.16	—‖
Malignant neoplasms	0.69 ± 0.248	0.59	0.54	0.84
Digestive	0.74¶	—‖	0.68	—‖
Respiratory	0.18¶	—‖	0.32	—‖
Leukemia and aleukemia	0.67¶	1.18	0.83	1.75
Accidents	0.34	0.22	0.49	0.71
Suicide	1.03	1.22	1.44	1.04
All other causes	0.46	0.34	0.22	—‖

* Total deaths listed by major category (italic) and specific causes (roman); age-adjusted ratios of observed deaths among anesthesiologists and other physicians to number expected among contemporaneous US white men, ±95% confidence limits shown where number of deaths are sufficient.

† This study.

‡ D. L. Bruce, and colleagues, unpublished data.

§ US male physicians (13, 14).

‖ Data not available.

¶ Ratios to US white male rates for 1940 only (12).

TABLE 5

Mortality Ratios of Anesthesiologists to Life Insurance Policyholders*

Cause of death	1930–1946†	1947–1956‡	1957–1966‡	1967–1971‡
All causes	1.09 ± 0.132	1.04	0.60	0.75
Cardiovascular-renal	1.22 ± 0.186	1.44	0.61	0.81
Vascular lesions of CNS	2.16 ± 0.730	1.30	0.77	0.89
Disease of heart	1.12 ± 0.205	1.48	0.62	0.85
Malignant neoplasms	0.59 ± 0.212	0.60	0.56	0.64
Digestive	1.13	0.62	0.64	0.71
Respiratory	0.06	0.11	0.30	0.48
Leukemia and aleukemia	0.45	1.33	0.91	0.40
Accidents	0.89	0.41	0.76	0.80
Suicides	2.78	2.20	2.86	2.98
All other causes	1.20	0.58	0.30	0.36

* Total deaths listed by major category (italic) and specific causes (roman); age-adjusted ratio of observed deaths among anesthesiologists to number expected among male standard ordinary policyholders of Metropolitan Life Insurance Company, 1966, ±95% confidence limits shown where number of deaths are sufficient.

† This study.

‡ American Society of Anesthesiologists members (16).

name of medical school, date of graduation, current and previous addresses, and other information. On notification of the death of a physician, the card was removed from the active file and placed in a death file. When removed from the active file, the date, place and often cause of death, and the source of this information were added to the card. The obituary from the *Journal of the American Medical Association* was often pasted to the card. Notifications of death were received from state boards, registrars of vital statistics, medical societies, colleagues, and families of the deceased. These records of the AMA are the most complete records available for physicians of the period. Short of searching the vital statistics records of each state and New York City for the 17-year period, they provide the best source of information available for this investigation.

Copies of death certificates were obtained by mail request from vital statistics offices.

Mortality

Deaths occurring among anesthesiologists were examined by the proportional death rate and by mortality ratios. Two standards were used to compute mortality ratios: expected deaths of contemporaneous US white men and expected deaths of life insurance policyholders during 1966. These latter comparisons were made because the desired vital statistics rates were available in appropriate detail (i.e., by age, race, sex, and cause) and to allow further comparison with other physicians and with anesthesiologists in later time periods.

The proportional death rate is a useful tool to examine the relative importance of different diseases in causing death. The proportional rate for a given cause, however, is affected not only by changes in the number of deaths from the cause, but also by changes in numbers of deaths from other causes.

Two comparison populations were selected for calculation of mortality ratios, US white men during 1930–1946, and male life insurance policyholders during 1966. Contemporary white men and anesthesiologists were exposed to the same environment (physical, chemical, biologic, etc). Inasmuch as anesthesiologists were of a higher socioeconomic class, they probably had superior nutrition, health care, and living conditions. This in turn could have contributed to lower death rates. Vital statistics by socioeconomic class for that time period are not available. The life insurance policyholders were generally employed and of somewhat higher socioeconomic class than US white men, but were not contemporaneous with the anesthesiologists studied. The use of the 1966 policyholder death rates allowed us, however, to make comparisons with anesthesiologists through 1971.

The three leading causes of death among anesthesiologists—diseases of the heart, vascular lesions of the central nervous system, and cancer—were the same as those for all physicians as a group living at the same time (13, 14). Anesthesiologists had nearly double the proportion of suicides, however. Data for physicians include those for anesthesiologists; however, this introduces little bias since less than 1% of all US physicians were anesthesiologists during the study period (2–6, 10).

When compared to contemporaneous nonphysician white men, mortality ratios of anesthesiologists from all causes were only three fourths of the ratios expected, about the same ratio as the expected for cardiovascular-renal diseases, and lower than the expected ratio for cancer, accidental death, and the residual (all other) causes. The lower mortality from cancer could have been due to earlier detection and treatment. The residual category includes some causes that were more prevalent in lower socioeconomic classes (e.g., tuberculosis). In contrast to anesthesiologists, other physicians of the same era experienced mortality similar to the white male population (13, 14). The reason for the difference in mortality from all causes is not clear from the available data, although cancer and accidental death ratios were lower for anesthesiologists.

When compared to policyholders, mortality ratios for anesthesiologists in this study were similar to those for anesthesiologists during 1947–1956, but were greater than those for anesthesiologists during 1957–1966 and 1967–1971. This pattern prevails for the cardiovascular-renal diseases combined, although vascular lesions of the central nervous system are a more prominent cause, and diseases of the heart less, in the study group years than in the next decade.

Overall cancer death ratios have changed little for anesthesiologists over the years, although the mortality ratios for digestive organ neoplasms were greatest during the study period. The respiratory system neoplasm mortality ratio increased steadily from 1930–1946 through 1967–1971, but it never reached one half of the expected rate.

Mortality ratios for neoplasms of the digestive organs decreased among anesthesiologists after 1930–1946, especially when compared to expected rates for policyholders. It is difficult to ascribe significance to this difference since small numbers of deaths are

involved and because the mortality ratio to contemporaneous white men is low. The two types of malignant tumors that were observed in rodents fed chloroform, i.e., kidney epithelial tumors and hepatocellular carcinoma, were not a prominent cause of death of anesthesiologists (1). In the study group of anesthesiologists there was one death from cancer of each of these organs, giving a proportional death rate of 0.4% for each. Comparison vital statistics are not available to calculate mortality ratios. Respiratory system neoplasm deaths were, in contrast, remarkably low during 1930–1946 and remained low for anesthesiologists through 1967–1971. The low rate observed by Bruce et al (15, 16) in the 1947–1966 study led them to investigate the cigarette smoking habits of anesthesiologists. They found no difference between anesthesiologists and the general population in their 1967–1971 study (21). Since the hazards of cigarette smoking were less well recognized before 1946, and since cigarettes were advertised in medical journals, it is unlikely that anesthesiologists smoked less than their white male contemporaries.

It was not possible to calculate mortality ratios to US white men for lymphosarcoma since this cause of death was not considered separately in vital statistics rates before 1948. Data are not available for this cause of death among the life insurance policyholders.

Suicide

Bruce et al (15, 16) found a high incidence of suicide among anesthesiologists as compared to white men or policyholders. This does not appear to be true for anesthesiologists during 1930–1946. Although their suicide rate was high when compared to white men or policyholders in later years, it was nearly equal to contemporaneous white men and physicians. During the depression years (1930–1940), the white male death rate for suicide was high (11).

Whereas the anesthesiologists considered here were listed as medical anesthetists in the IARS directories it is impossible to ascertain how much of their time was devoted to anesthesia; their exposure to anesthetics is therefore difficult to estimate. Full-time medical specialization was much less common in those years and it is likely that many were part-time anesthesiologists. Nonetheless, their mortality experience differs from contemporaneous physicians as a whole and is similar to that of anesthesiologists in the subsequent decade who must have experienced similar anesthetic exposure.

Lew (20) has studied deaths of anesthesiologists from 1954–1976, using the membership lists of the American Society of Anesthesiologists as the population. For calculation of mortality ratios, he compared anesthesiologists to US physicians. He also subdivided his population to examine those practicing before and after the introduction of halothane. He found that the major causes of death in both groups were cardiovascular disease and cancer and both groups also had a high suicide rate. In both, Lew's findings parallel those of this study. The mortality ratio found by Lew for deaths from all causes during 1954–1976 does not differ from that for anesthesiologists during 1930–1946. He observed a downward trend in mortality ratios over time, an observation consistent with our findings when compared to those of Bruce et al (15, 16). Lew concluded that there was no increase in overall mortality or mortality from cancer subsequent to the introduction of halothane. This is also consistent with our conclusions.

Conclusions

The practice of anesthesiology in the early part of the 20th century did not increase risk of death of its practitioners. It appears that occupational exposure to the anesthetic vapors then in use did not have adverse health effects, at least as reflected in mortality statistics. Death rates for anesthesiologists were similar in the periods 1930–1946 and 1947–1956, before the introduction of the fluorinated anesthetic agents. Death rates decreased over the period 1957–1976 after the introduction of these agents. This suggests that the fluorinated agents do not adversely effect the health of anesthesiologists, although 20 years may be insufficient time for such effects to become manifest in death rates.

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